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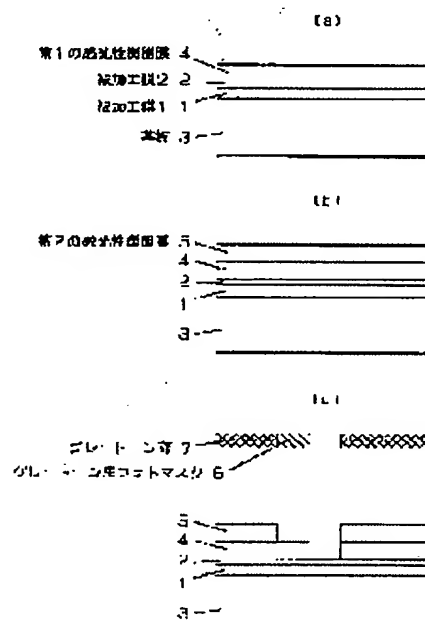
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## (54) METHOD FOR APPLYING PHOTOSENSITIVE RESIN AND METHOD FOR DRYING THE SAME

## (57)Abstract:

PROBLEM TO BE SOLVED: To solve the problem that it is difficult to make a photosensitive resin film uniform in thickness in gray tone exposure.

SOLUTION: A photosensitive resin is applied in the thickness of a photosensitive resin film to be left in gray tone exposure and the photosensitive resin is repeatedly applied so as to obtain the conventional film thickness. Drying is carried out every time the resin is applied and the concentration of a solvent in the photosensitive resin is varied in the first and second applications.



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CLAIMS

[Claim(s)]

[Claim 1] The method of application of the photopolymer characterized by performing once [ at least ] applying a photopolymer to said substrate side where said photopolymer was applied further after applying a photopolymer to the substrate with which it faced that ultraviolet radiation performed patterning of a photopolymer, and the processed film was formed.

[Claim 2] The desiccation approach of the photopolymer characterized by performing once [ at least ] applying a photopolymer to the substrate side where said photopolymer was applied further, and carrying out fixed time amount generation of heat of said heating element after carrying out fixed time amount generation of heat of the heating element from the substrate upper part where the photopolymer was applied to the substrate and said photopolymer was applied.

[Claim 3] The exoergic time amount of the heating element after photopolymer spreading is the desiccation approach of the photopolymer according to claim 2 lengthened whenever it repeats spreading.

[Claim 4] The solvent concentration of the photopolymer applied to a substrate is the method of application of a different photopolymer according to claim 1 from what is applied first, and the thing applied to 2nd henceforth.

[Claim 5] The solvent concentration of the photopolymer applied to a substrate is the method of application of the photopolymer according to claim 4 made small whenever it repeats spreading.

[Claim 6] Face etching the processed film used as a multilayer continuously, and the thickness of the photopolymer applied to the substrate with which said processed film is formed at the n-th time ( $n=1, 2, \dots$ ) removes the photopolymer applied to last. The method of application of a photopolymer given in either of claims 1, 4, and 5 which are the amounts of photopolymer thickness etched by the time amount except the time amount which etches the processed film of eye watch from etching time ( $n+1$ ).

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**DETAILED DESCRIPTION****[Detailed Description of the Invention]****[0001]**

**[Field of the Invention]** This invention relates to the patterning approach which creates two or more thickness of a photopolymer by one exposure using the photo mask for gray tones with which the permeability of ultraviolet radiation differs gradually.

**[0002]**

**[Description of the Prior Art]** In recent years, the exposure approach called gray tone exposure is put in practical use. By the conventional exposure approach, patterning of the processed film under it was carried out by one of the part which leaves a photopolymer, and the parts to remove according to the existence of a photopolymer. On the other hand, after gray tone exposure forms the multilayer processed film, in addition to the part which leaves the photopolymer conventional by one exposure, and the part to remove, it tends to create what made thickness of the part to leave thin, tends to carry out patterning of the multilayer processed film at once, and tends to reduce the count of exposure. It is carried out at the process which shows the patterning approach using the photo mask for gray tones below here.

**Spreading:** Apply a photopolymer.

**The solvent of the photopolymer prebaked :** applied is heated and removed.

**Exposure:** Perform exposure using the photo mask for gray tones.

**Development, a rinse:** Perform development and washing.

**Postbake:** Heat and remove the developer and penetrant remover which remained into the photopolymer.

**[0003]** Consequently, the part in which the thickness which applied the photopolymer mostly remains, the completely removed part, and the part which left those middle thickness are created. By the pattern below the resolution of the exposure machine to be used, the photo mask of the part made into this middle thickness is constituted, is reducing the ultraviolet radiation to penetrate and is usually equalizing.

**[0004]**

**[Problem(s) to be Solved by the Invention]** However, since the middle thickness part of this photopolymer did not have enough light exposure, it had the problem that the surface smoothness on the front face of the film was missing. If ultraviolet radiation is irradiated by the photopolymer, molecular weight change or a soluble radical will be generated, the difference of solubility will be produced, but if this has few exposures of ultraviolet radiation, since the above-mentioned reaction is inadequate, it will be because the homogeneity on the front face of a photopolymer after development worsens. Moreover, if the surface smoothness on the front face of a photopolymer is bad, the heterogeneity will be imprinted by the workpiece side at the time of a next etching process. Then, this invention aims at offering the manufacture process in which the photopolymer film generated in the gray tone exposure section creates the thing excellent in surface smoothness, and equipment in view of the above-mentioned trouble.

**[0005]**

**[Means for Solving the Problem]** In order to attain the purpose which creates the thing excellent in the surface smoothness of the photopolymer film of the above-mentioned gray tone exposure

section It performs once [ at least ] applying a photopolymer to the substrate side where said photopolymer was applied further, after applying a photopolymer to a substrate in the first place, A heating element is laid above the substrate with which the photopolymer was applied [ second ], After making the substrate with which the photopolymer was applied [ third ] to the substrate and said photopolymer was applied carry out fixed time amount generation of heat of said heating element, It performs once [ at least ] applying a photopolymer to the substrate side where said photopolymer was furthermore applied, and carrying out fixed time amount generation of heat of said heating element, It lengthens, whenever the exoergic time amount of the heating element after photopolymer spreading repeats spreading to the fourth, The viscosity of the photopolymer applied [ fifth ] to a substrate differs from what is applied first, and the thing applied to 2nd henceforth, The thickness of the photopolymer applied to making it small whenever the viscosity of the photopolymer applied [ sixth ] to a substrate repeats spreading, and the seventh substrate is considering as the photopolymer thickness etched at an etching process except for the photopolymer applied to last.

[0006]

[Embodiment of the Invention] (Gestalt 1 of operation) Below, a drawing is used and the example of this invention is explained. Drawing 1 is process drawing explaining the method of application of the photopolymer of the example of this invention. Drawing 1 (a) applies 6000A of positive type photopolymers to the glass substrate 3 with which SiN was formed as processed film 1 and it formed 1500A of a-Si as 3000A and processed film 2 by the spin coater as 1st photopolymer film 4. Drawing 1 (b) applies 6000A of positive type photopolymers by the spin coater as 2nd photopolymer film 5 on the 1st photopolymer film 4. Drawing 1 (c) shows the cross-section configuration of the photopolymer after using and developing [ expose and ] the photo mask 6 for gray tones. Surface smoothness became good by the photopolymer thickness corresponding to the gray tone section 7 adjusting light exposure, and considering as the thickness of the 1st photopolymer film 4 exactly. Photosensitivity becomes good and this is because an exposure reaction progresses, so that the solvent concentration of a photopolymer is low. That is, spreading of the 1st photopolymer film 4 evaporates a solvent from a photopolymer film front face (upper part). If the 2nd photopolymer film 5 is applied on it, in order that a solvent may move to the upper part of the 1st photopolymer film 4 from the lower part of the 2nd photopolymer film 5 based on the concentration difference of a solvent, the solvent concentration of the 2nd photopolymer film 5 lower part turns into low concentration. Consequently, if the light exposure which exposes thickness extent of the 2nd photopolymer film 5 is given, an exposure reaction will progress to the lower part of the 2nd photopolymer film 5, and only the 2nd photopolymer film 5 will be eluted. If the usual photopolymer film is applied at once, since the solvent concentration in the film is also continuous, it will become continuous [ the sensitization section ] and the surface smoothness of the photopolymer thickness after development will improve worsening.

[0007] Moreover, the thickness of the 1st photopolymer film 4 is determined from the thickness of the processed film 1 and 2, and the etching rate of an etching system. a-Si, SiN, and the photopolymer of the etching rate were 1500, and 1000 or 2000A / min, respectively. For etching all of a-Si and SiN, the thickness of  $1500A / (1500A / \text{min}) + 3000A / (1000A / \text{min}) = 4\text{min}$ , therefore the 1st photopolymer film 4 becomes  $2000A / \text{min} \times (4\text{min} - 1500A / (1500A / \text{min})) = 6000A$ .

[0008] (Gestalt 2 of operation) Drawing 2 is drawing showing the process flow of other examples of this invention. SiN and a-Si were formed to the glass substrate, and 6000A of positive type photopolymers was applied. Generation of heat and a photopolymer were dried for the lamp (not illustrating 250 Wx2) of the substrate upper part for 30 seconds after that. And 6000A of positive type photopolymers was applied again, and then generation of heat and a photopolymer were dried for the lamp of the substrate upper part for 40 seconds. Then, it exposed using the photo mask for gray tones, and development and a rinse were performed. As a result, the surface smoothness of the photopolymer film of the gray tone section became still better. after performing gray tone exposure, development, a rinse, and baking for that to which drawing 3 (a) appeared further and applied the conventional photopolymer, the thing which applied (b) by the

bilayer, and the thing which (c) added the desiccation process for every spreading of a photopolymer, and was made into the bilayer, respectively, the photopolymer film of the gray tone section was measured with the sensing-pin type level difference plan. By the case where each is considered as 6000A as desired value of photopolymer thickness, the irregularity of thickness with a distance of about 150 micrometers was investigated. It turns out that (c) has become [ the surface smoothness of a photopolymer ] the best so that clearly from this drawing. By adding a desiccation process for every spreading of a photopolymer, this is because the solvent concentration in a photopolymer becomes low and photosensitivity is promoted. In addition, as the desiccation approach, since the direction of the heating approach from the substrate upper part promotes desiccation of the photopolymer by the side of the upper part from a substrate lower part, it becomes better.

[0009] (Gestalt 3 of operation) Drawing 4 is drawing showing the process flow of other examples of this invention. SiN and a-Si are formed to a glass substrate, 6000A of positive type photopolymers of 20cp was applied, and they were dried. Next, 6000A of positive type photopolymers of 40cp was applied, and they were dried. Gray tone exposure, development, and a rinse were performed after that. Consequently, the surface smoothness of the photopolymer film of the gray tone section became better than the case where the photopolymer of the same solvent concentration is continued and applied. This is because the solvent concentration of the photopolymer of the upper layer which should be removed is low, so a photosensitivity difference with a lower layer photopolymer becomes clear.

[0010]

[Effect of the Invention] What excelled [ apply / the photopolymer of different solvent concentration which repeats spreading in order according to this invention to apply a part for the photopolymer thickness which it should leave by gray tone exposure and to usually make a photopolymer into thickness further, and dries for every spreading ] in the surface smoothness of the photopolymer thickness of the gray tone section can be manufactured as mentioned above, and it has very big effectiveness on industry.

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**DESCRIPTION OF DRAWINGS**

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[Brief Description of the Drawings]

[Drawing 1] Drawing showing the process of the outline of the gestalt of operation of this invention

[Drawing 2] Drawing showing the flow of the gestalt of other operations of this invention

[Drawing 3] Drawing showing the surface smoothness of the photopolymer thickness in an all directions method

[Drawing 4] Drawing showing the flow of the gestalt of other operations of this invention

[Description of Notations]

1 Processed Film 1

2 Processed Film 2

3 Substrate

4 1st Photopolymer Film

5 2nd Photopolymer Film

6 Photo Mask for Gray Tones

7 Gray Tone Section

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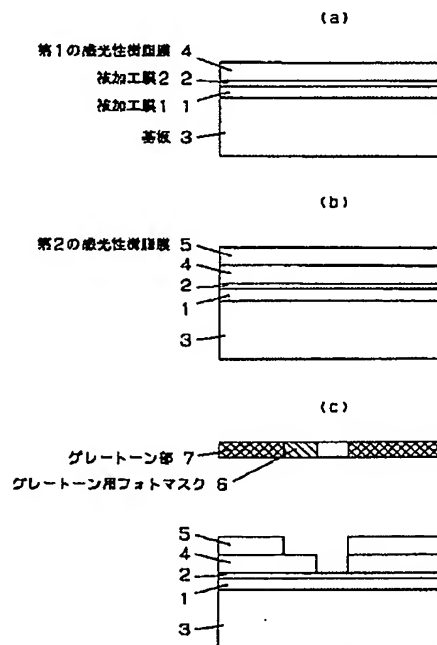
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(54) 【発明の名称】 感光性樹脂の塗布方法及び乾燥方法

(57) 【要約】

【課題】 グレートーン露光では、感光性樹脂膜の膜厚平坦化を図ることは難しかった。

【解決手段】 グレートーン露光で残すべき感光性樹脂膜厚分を塗布し、さらに感光性樹脂を通常膜厚とするため塗布を繰り返す、また塗布毎に乾燥を行う、異なる溶媒濃度の感光性樹脂を塗布する。



## 【特許請求の範囲】

【請求項 1】 紫外光により感光性樹脂のパターニングを行うに際し、被加工膜が成膜された基板に感光性樹脂を塗布した後、さらに前記感光性樹脂が塗布された前記基板面に感光性樹脂を塗布することを少なくとも 1 回行うことを特徴とする感光性樹脂の塗布方法。

【請求項 2】 基板に感光性樹脂を塗布し、前記感光性樹脂が塗布された基板上より発熱体を一定時間発熱させた後、さらに前記感光性樹脂が塗布された基板面に感光性樹脂を塗布し前記発熱体を一定時間発熱させることを少なくとも 1 回行うことを特徴とする感光性樹脂の乾燥方法。

【請求項 3】 感光性樹脂塗布後の発熱体の発熱時間は塗布を繰り返す毎に長くする請求項 2 記載の感光性樹脂の乾燥方法。

【請求項 4】 基板に塗布する感光性樹脂の溶媒濃度は最初に塗布するものと、2 回目以降に塗布するものと異なる請求項 1 記載の感光性樹脂の塗布方法。

【請求項 5】 基板に塗布する感光性樹脂の溶媒濃度は塗布を繰り返す毎に小さくする請求項 4 記載の感光性樹脂の塗布方法。

【請求項 6】 多層となっている被加工膜を連続的にエッチングするに際し、前記被加工膜が成膜されている基板に  $n$  回目 ( $n = 1, 2, \dots$ ) に塗布する感光性樹脂の膜厚は最終に塗布する感光性樹脂を除き、エッチング時間から  $(n + 1)$  番目の被加工膜をエッチングする時間を除いた時間でエッチングされる感光性樹脂膜厚量である請求項 1, 4, 5 のいずれかに記載の感光性樹脂の塗布方法。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】本発明は、紫外光の透過率が段階的に異なるグレートーン用フォトマスクを用いて、1 回の露光で感光性樹脂の膜厚を複数作成するパターニング方法に関する。

## 【0002】

【従来の技術】近年、グレートーン露光と呼ばれる露光方法が実用化されている。従来の露光方法では感光性樹脂を残す部分と除去する部分のどちらかで、感光性樹脂の有無に応じてその下の被加工膜がパターニングされていた。これに対してグレートーン露光は多層の被加工膜を形成した後、一回の露光で従来の感光性樹脂を残す部分、除去する部分に加え、残す部分の膜厚を薄くしたものを作成し、多層の被加工膜を一度にパターニングし、露光回数を減らそうとするものである。ここでグレートーン用フォトマスクを用いたパターニング方法は以下に示す工程で行われている。

塗布：感光性樹脂を塗布する。

プリベーク：塗布された感光性樹脂の溶剤を加熱、除去する。

露光：グレートーン用フォトマスクを用いた露光を行う。

現像、リンス：現像、洗浄を行う。

ポストベーク：感光性樹脂中に残った現像液、洗浄液を加熱、除去する。

【0003】この結果、感光性樹脂はほぼ塗布した膜厚が残っている部分、全く除去された部分、それらの中間の膜厚を残した部分が作成される。この中間の膜厚とする部分のフォトマスクは通常、使用する露光機の解像度以下のパターンで構成し、透過する紫外光を低減、均一化している。

## 【0004】

【発明が解決しようとする課題】しかしながら、この感光性樹脂の中間の膜厚部分は露光量が十分でないため、膜表面の平坦性に欠けるといった問題があった。これは感光性樹脂に紫外光が照射されると、分子量変化あるいは溶解性の基を生成して溶解度の差を生じさせるが、紫外光の照射が少ないと上記反応が不十分なため現像後の感光性樹脂表面の均一性が悪くなることによる。また、感光性樹脂表面の平坦性が悪いと、後のエッチング工程時にその不均一性が被加工物面に転写される。そこで本発明は上記の問題点を鑑み、グレートーン露光部で生成される感光性樹脂膜が平坦性に優れたものを作成する製造プロセス、装置を提供することを目的とする。

## 【0005】

【課題を解決するための手段】上記のグレートーン露光部の感光性樹脂膜の平坦性が優れたものを作成する目的を達成するために、第一に基板に感光性樹脂を塗布した後、さらに前記感光性樹脂が塗布された基板面に感光性樹脂を塗布することを少なくとも 1 回行うこと、第二に感光性樹脂が塗布された基板の上方に発熱体を載置すること、第三に基板に感光性樹脂を塗布し、前記感光性樹脂が塗布された基板に前記発熱体を一定時間発熱させた後、さらに前記感光性樹脂が塗布された基板面に感光性樹脂を塗布し前記発熱体を一定時間発熱させることを少なくとも 1 回行うこと、第四に感光性樹脂塗布後の発熱体の発熱時間は塗布を繰り返す毎に長くすること、第五に基板に塗布する感光性樹脂の粘度は最初に塗布するものと、2 回目以降に塗布するものと異なること、第六に基板に塗布する感光性樹脂の粘度は塗布を繰り返す毎に小さくすること、第七に基板に塗布する感光性樹脂の膜厚は、最終に塗布する感光性樹脂を除きエッチング工程でエッチングされる感光性樹脂膜厚とすることである。

## 【0006】

【発明の実施の形態】（実施の形態 1）次に本発明の実施例を図面を用いて説明する。図 1 は本発明の実施例の感光性樹脂の塗布方法を説明する工程図である。図 1

（a）は被加工膜 1 として SiN を  $3000 \text{ \AA}$ 、被加工膜 2 として a-Si を  $1500 \text{ \AA}$  成膜したガラス基板 3 に第 1 の感光性樹脂膜 4 としてポジ型感光性樹脂をスピ

ンコーターで6000Å塗布したものである。図1

(b)は第1の感光性樹脂膜4の上に第2の感光性樹脂膜5としてポジ型感光性樹脂をスピナーで6000Å塗布したものである。図1(c)はグレートン用フォトマスク6を用いて露光、現像した後の感光性樹脂の断面形状を示したものである。グレートン部7に対応する感光性樹脂膜厚は、露光量を調節してちょうど第1の感光性樹脂膜4の膜厚とすることにより平坦性が良くなった。これは感光性樹脂の溶媒濃度が低い程、光感度が良くなり、露光反応が進むことによる。つまり第1の感光性樹脂膜4は塗布されると感光性樹脂膜表面(上部)から溶媒が蒸発する。その上に第2の感光性樹脂膜5を塗布すると溶媒の濃度差に基づき、第2の感光性樹脂膜5の下部から第1の感光性樹脂膜4の上部に溶媒が移動するため、第2の感光性樹脂膜5下部の溶媒濃度は低濃度になる。その結果、第2の感光性樹脂膜5の膜厚程度を感光させる露光量を与えると、第2の感光性樹脂膜5の下部まで露光反応が進み第2の感光性樹脂膜5のみが溶出する。通常の感光性樹脂膜を1回で塗布すると、膜中の溶媒濃度も連続的であるため感光部も連続的となり、現像後の感光性樹脂膜厚の平坦性が悪くなることを改善したものである。

【0007】また、第1の感光性樹脂膜4の膜厚は、被加工膜1、2の膜厚、エッチング装置のエッチングレートより決定される。エッチングレートはa-Si、SiN、感光性樹脂がそれぞれ、1500、1000、2000Å/minであった。a-Si、SiNを全てエッチングするには

$$1500\text{Å}/(1500\text{Å}/\text{min}) + 3000\text{Å}/(1000\text{Å}/\text{min}) = 4\text{min}$$

従って、第1の感光性樹脂膜4の膜厚は

$$2000\text{Å}/\text{min} \times (4\text{min} - 1500\text{Å}/(1500\text{Å}/\text{min})) = 6000\text{Å}$$

となる。

【0008】(実施の形態2)図2は本発明の他の実施例の工程フローを示す図である。ガラス基板にSiN、a-Siを成膜し、ポジ型感光性樹脂を6000Å塗布した。その後基板上方のランプ(図示せず、250W×2)を30秒間発熱、感光性樹脂を乾燥させた。そして、再びポジ型感光性樹脂を6000Å塗布し、次に基板上方のランプを40秒間発熱、感光性樹脂を乾燥させた。その後、グレートン用フォトマスクを用いて露光し、現像、リンスを行った。その結果グレートン部の感光性樹脂膜の平坦性は更に良くなった。図3(a)は従来の感光性樹脂を一層で塗布したものの、(b)は二層

で塗布したものの、(c)は感光性樹脂の塗布毎に乾燥工程を加え二層にしたものを夫々グレートン露光、現像、リンス、ベーキングを行なったのち、グレートン部の感光性樹脂膜を触針式段差計で計測した。感光性樹脂膜厚の目標値として何れも6000Åとした場合で、約150μmの距離での膜厚の凹凸を調べた。この図から明らかなように、(c)が感光性樹脂の平坦性が最も良くなっていることがわかる。これは感光性樹脂の塗布毎に乾燥工程を加えることにより、感光性樹脂中の溶媒濃度が低くなり光感度が促進されることによる。なお、乾燥方法としては基板下方からよりも基板上方からの加熱方法の方が、上部側の感光性樹脂の乾燥を促進させるのでより良くなる。

【0009】(実施の形態3)図4は本発明の他の実施例の工程フローを示す図である。ガラス基板にSiN、a-Siを成膜し、20cpのポジ型感光性樹脂を6000Å塗布し、乾燥させた。次に40cpのポジ型感光性樹脂を6000Å塗布し、乾燥させた。その後グレートン露光、現像、リンスを行った。その結果、グレートン部の感光性樹脂膜の平坦性は同一溶媒濃度の感光性樹脂を続けて塗布する場合より良くなった。これは除去すべき上層の感光性樹脂の溶媒濃度が低いため、下層の感光性樹脂との光感度差が明確になるからである。

【0010】

【発明の効果】以上のように本発明によれば、グレートン露光で残すべき感光性樹脂膜厚分を塗布し、さらに感光性樹脂を通常膜厚とするため塗布を繰り返す、また塗布毎に乾燥を行う、異なる溶媒濃度の感光性樹脂を塗布することで、グレートン部の感光性樹脂膜厚の平坦性の優れたものが製造でき、工業上極めて大きな効果を有する。

【図面の簡単な説明】

【図1】本発明の実施の形態の概略の工程を示す図

【図2】本発明の他の実施の形態のフローを示す図

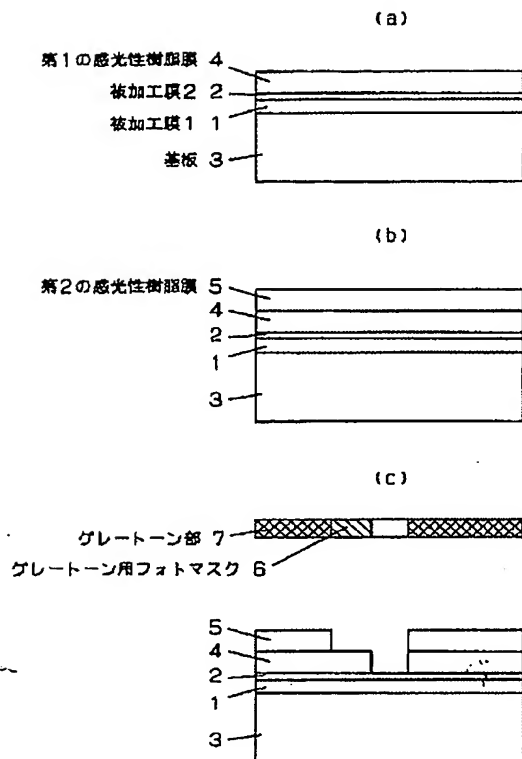
【図3】各方法での感光性樹脂膜厚の平坦性を示す図

【図4】本発明の他の実施の形態のフローを示す図

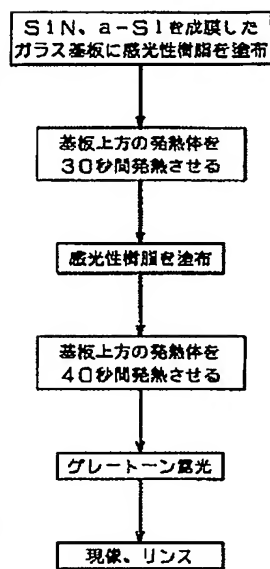
【符号の説明】

- 1 被加工膜1
- 2 被加工膜2
- 3 基板
- 4 第1の感光性樹脂膜
- 5 第2の感光性樹脂膜
- 6 グレートン用フォトマスク
- 7 グレートン部

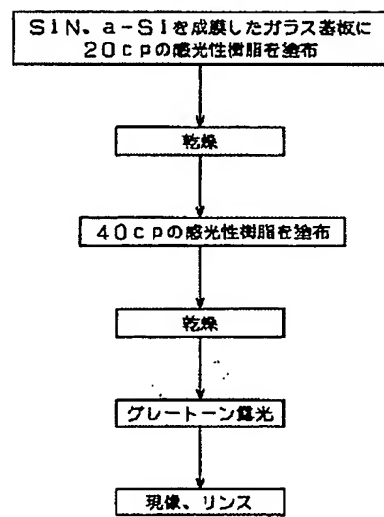
【図1】



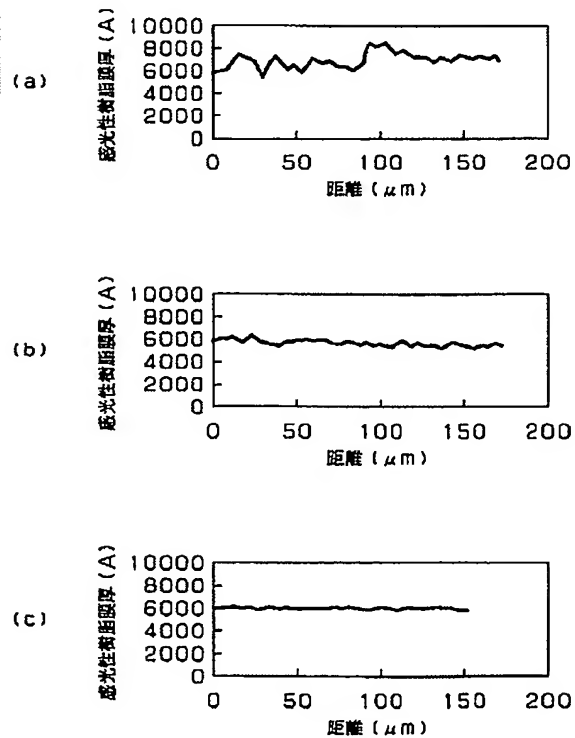
【図2】



【図4】



【図3】



(5)

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